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The distribution and inter-relationships of radiologic features of osteoarthrosis of the hip
A survey of 4151 subjects of the Copenhagen City Heart Study: The Osteoarthrosis Substudy[1]

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Summary

Objective: The aims of this study were to investigate the influence of sex, age and individual physical and occupational factors on the distribution of radiographic features of hip joint osteoarthritis (OA), and to determine the inter-relationships between the primary radiographic OA discriminator of reduced joint space width (JSW), and secondary radiographic OA features.

Method: The study was a cross-sectional survey. Radiologic features of hip OA were recorded from standardized, standing pelvic radiographs of 3686 subjects (1397M/2289F). OA features were investigated for inter-relationships and correlations to age, sex, body mass index (BMI) and occupational exposure to repeated lifting.

Results: Overall, subchondral sclerosis, cysts and osteophytes were more frequently recorded in male hip joints compared to female hip joints, while a decrease in minimum JSW by age was more pronounced and progressive in women after the fifth decade compared to men. Applying logistic regression analyses, only age was found to be significantly associated to pathologically reduced minimum JSW (cut off value set at $\leq$2.0 mm), and the presence of osteophytes and subchondral cysts in both sexes (P ranging from 0.00 to 0.03). Minimum JSW $\leq$2.0 mm was recorded in 105 male hip joints, and in 167 female hip joints. In these joints, subchondral cysts, osteophytes and sclerosis were found to be significantly inter-related to minimum JSW $\leq$2.0 mm according to logistic regression analysis. The presence of subchondral cysts had the highest predictive sensitivity in regard to pathologically reduced minimum JSW compared to subchondral sclerosis and osteophytes.

Conclusions: We believe that an accurate radiologic case definition of hip OA will rest on a combination of features. Only studies of the distribution of features, singularly and in combination, applied to clinically evaluated large cohorts may provide the optimum answer to the best possible clinical case definition of hip OA.

Key words: Hip, Coxarthrosis, Hip osteoarthritis, Radiologic epidemiology.

Introduction

Reduced joint space width (JSW), subchondral sclerosis and the formation of osteophytes and subchondral cysts are the primary radiologic features of degenerative joint disease. They are emphasized by radiologic osteoarthritis (OA) discriminators such as Lawrence–Kellgren's classification or Croft's classification[1,2]. In combination with characteristic symptoms they constitute criteria of the research of OA. Especially the measurement of minimum JSW has been found to accurately reflect clinical status and progression of hip OA, and must be considered as the primary radiographic index of OA presence and development, while the formation of subchondral cysts, osteophytes and subchondral sclerosis may be considered as secondary radiographic features of OA[3–6]. Until recently, individual radiologic features of hip OA had not been evaluated in terms of age, sex or physical parameters in asymptomatic subjects. However, Lanyon *et al.* documented a decrease in minimum hip JSW in asymptomatic women by age[7]. Lanyon *et al.* found that minimum JSW was generally higher in men.

The aim of the current study was to establish the initial foundation for a workable and accurate case definition of radiologic coxarthrosis for further epidemiological use. The authors have registered radiologic features of OA in 8304 hips in standardized, standing pelvic radiographs of the cohort of the third Copenhagen City Heart Study: the Osteoarthrosis Substudy (CCHS III) recorded from 1991 to 1994. The radiologic features of hip OA were investigated for inter-relationships. The influence of age, sex, and

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individual physical and occupational parameters on radiologic features of hip OA was investigated.

Material and methods

THE COPENHAGEN CITY HEART STUDY: THE OSTEOARTHRITIS SUBSTUDY

The Copenhagen City Heart Study (CCHS) is a longitudinal health survey of an adult almost entirely Caucasian population in the county of Österbro in Copenhagen, Denmark. The survey has registered life style factors, cardiopulmonary disease, and musculoskeletal disease of the participants four times since its beginning in 1976[8].

The CCHS III cohort of 1991–1994 consisted of 10,135 participants (4437M/5698F). All participants answered a subset questionnaire of 50 questions covering physical history and the need for medical or surgical treatment of musculoskeletal disorders. From the cohort 2949 subjects were initially selected for radiography of the pelvis, the knees, the hands, the wrists and the lumbar spine. The inclusion criteria into the radiographic examination protocol were positive answers in four or more of the 50 musculoskeletal questions. In addition, 1202 subjects of the CCHS III cohort with positive answers in three or less of the main musculoskeletal questions were selected as sex and age matched controls. A total of 4151 subjects (40.9%) of the initial cohort were thus selected for radiography.

To be able to pool the radiographic material from the primarily selected subjects and the matched controls for this study, we retraced the answers of the baseline questionnaire regarding hip pain in both groups. The subset questions regarding self reported hip pain were the following: (1) "Have you experienced recurrent hip pain during the last 12 months?", (2) "Have you experienced frequent and recurrent deep pain in the groins during the last 12 months?", and (3) "Have you experienced frequent and recurrent deep pain in the buttocks during the last 12 months?". The precise formulation was chosen to assess structural change over time.

RADIOGRAPHIC EXAMINATION

Antero-posterior (AP) pelvis and lateral lumbar spine radiographs were recorded standing. Feet pointed straight forward, and lower extremities were positioned in neutral abduction–adduction along the functional axis. In AP pelvic radiographs the X-ray beam was centered two finger-breadths over the symphysis pubis in the vertical midline. The X-ray beam in lateral lumbar spine radiographs was centered at the apical midpoint of the iliac crista. Tube to film distance was 120 cm in all cases. Two radiology technicians obtained all radiographs and aimed at neutral pelvic rotation during recording.

RADIOGRAPHIC MEASUREMENTS

Hip JSW was measured at three locations: (1) at the lateral margin of the subchondral sclerotic line (*the sourcil*), denoting the lateral aspect of the weight-bearing surface, (2) at the apical transection of the weight-bearing surface by a vertical line through the center of the femoral head, and (3) at the medial margin of the weight-bearing surface bordering on the fovea. Minimal JSW was selected as the smallest of these three measurements, or as a fourth measurement, if maximum narrowing was present outside the chosen locations. Maximum vertical thickness of subchondral sclerosis was measured at one location (Fig. 1). Formation of osteophytes was recorded at: (1) the superior and inferior articulating parts of the femoral head, (2) the supero-lateral margin of the acetabulum, and (3) the infero-medial margin of the acetabulum. Subcondral cysts were recorded in (1) the 1 cm subchondral zone of the femoral head, and (2) the 1 cm subchondral zone of the acetabulum.

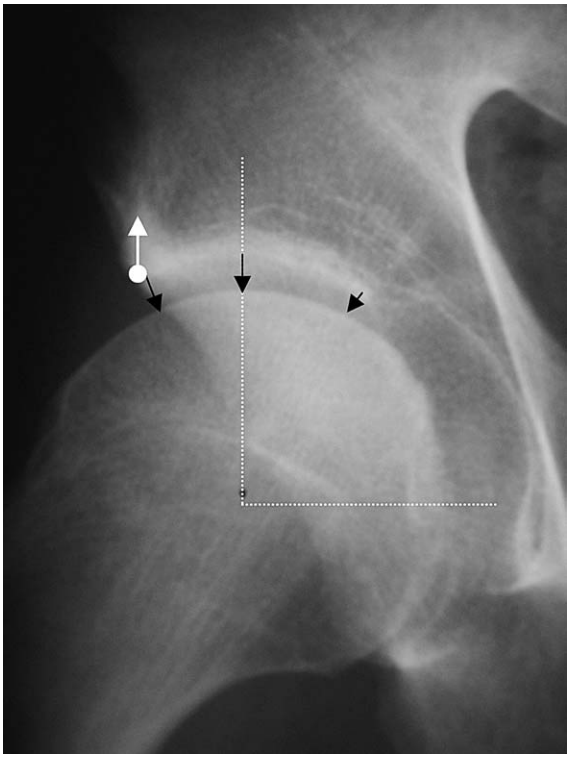

Fig. 1. Locations of the measurements of hip joint space widths and thickness of subcondral sclerosis.

One observer (SJ) performed all measurements of JSW and thickness of subchondral sclerosis using a 0.1 mm graded magnifying glass (Peak, Japan).

Pelvic inclination was measured in lateral lumbar spine radiographs as the angle between the horizontal plane and a line parallel to the cranial articulating surface of the sacrum. We believe that extreme pelvic inclination during standing pelvic X-ray recordings constitutes a possible source of error of JSW measurements, and radiographs with pelvic inclinations outside 2 standard deviations (SD) of the mean were omitted from the study. In males, mean pelvic inclination was 38.0° (1 SD = 9.3°). In females mean pelvic inclination was 38.0° (1 SD = 9.5°). Pelvic inclusion limits thus ranged from 19.3° to 56.7°, and female inclusion limits ranged from 18.9° to 57.1°.

PHYSICAL PARAMETERS AND OCCUPATION

During the general CCHS III examination, height and weight were recorded and body mass index (BMI) was calculated for each individual (kg/m^2).

The general CCHS III questionnaire has recorded the nature and duration of occupation since leaving school. For each occupation reported, the CCHS III has registered frequency of different levels of lifting during a typical

working day. The questions concerning occupation were formulated along the guidelines of The Danish National Board of Industrial Injuries, using the following categories: (1) primarily seated occupation, (2) standing, walking occupation, no repeated lifting, (3) daily repeated lifting equivalent to 50×20 kg, or 20×50 kg, (4) repeated daily lifting equivalent to 50–100×20 kg, or 20–50×50 kg, (5) repeated daily lifting equivalent to 100–250×20 kg, or 50–100×50 kg, and (6) repeated daily lifting equivalent to 250–500×20 kg, or 100–250×50 kg.

EXCLUSION

The following criteria for exclusion were applied: (1) pelvic inclination outside 2 SD, (2) former hip surgery in any hip, (3) a history of proximal femoral fractures, (4) a history of treatment of childhood hip disorders, and (5) a history of rheumatoid arthritis (RA) of any joint.

REPRODUCIBILITY

Intra-observer reproducibility of measurements of JSW and thickness of subchondral sclerosis were assessed by blinded re-reading of a subset of 50 CCHS III radiographs 4 weeks after first reading (SJ). Reproducibility of continuous variables was assessed using the method of Bland and Altman[9].

STATISTICAL ANALYSIS

Independent samples *t* tests were used to assess differences between the initially selected subjects and control subjects in regard to differences of the distribution of radiologic features of hip OA, and self reported hip pain. Independent samples *t* tests were used to investigate sex-related differences in the distribution of radiologic features of hip OA. Binary logistic regression analyses were used to investigate associations between age, BMI, and occupational factors and the presence of radiologic features of hip OA. Stepwise, binary logistic regression analysis was used to test inter-relationships between the primary hip OA discriminator of minimum JSW $\leq$2.0 mm, and the secondary radiographic OA features of cysts, osteophytes and subchondral sclerosis. Significance level was set at $P<0.05$. All statistical analyses were performed with the SPSS 11.5 statistical software (SPSS, Chicago, IL).

Results

INCLUSION AND MEASUREMENTS

The primarily selected cohort of 2949 subjects, and the control cohort of 1202 subjects selected into the radiography protocol, did not differ significantly in regard to self reported pain in or around the hip joints (*P* range, 0.24–0.65). Furthermore, the groups did not differ in regard to the formation of osteophytes, subchondral cysts, subchondral sclerosis and minimum JSW (*P* range, 0.15–0.79). The two groups were regarded as one united cohort for this study, and radiographs were pooled.

After individual exclusion criteria were applied, this study finally included 1397 men with a mean age of 61 years (range, 23–93 years) and 2289 women with a mean age of 62 years (range, 22–92 years) (Fig. 2).

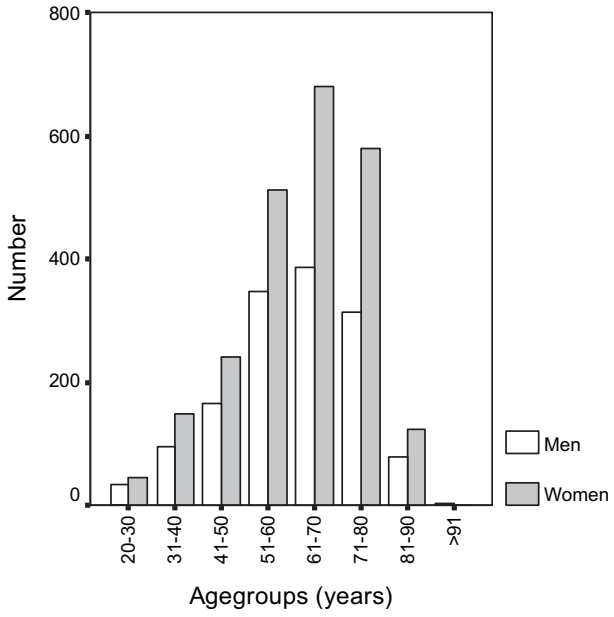

Fig. 2. Agegroup distribution.

REPRODUCIBILITY

Repeatability of measurements of minimum JSW and maximum subchondral sclerosis in CCHS III radiographs were acceptable (95% of differences $<$0.35 mm for minimum JSW and 95% of differences $<$0.24 mm for maximum subchondral sclerosis).

SEX-RELATED DIFFERENCES IN RADIOLOGIC FEATURES OF HIP OA

Mean minimum JSW was 3.90 mm (SD = 0.89 mm) in right male hip joints, and 3.87 mm (SD = 0.92 mm) in left male hip joints. Mean minimum JSW was 3.7 mm (SD = 0.84 mm) in right female hip joints and 3.72 (SD = 0.81 mm) in left female hip joints. Mean maximum subchondral sclerosis was 3.02 mm (SD = 1.2 mm) in right male hip joints, and 3.21 mm (SD = 1.3 mm) in left male hip joints. The corresponding female values were 2.62 mm (SD = 1.1 mm) in right hip joints, and 2.79 mm (SD = 1.2 mm) in left hip joints. Minimum JSW was significantly narrower in females than in males ($P = 0.00$). Thickness of subchondral sclerosis was larger in men ($P = 0.00$). The distributions of minimum JSW and maximum subchondral sclerosis are presented in Figs. 3 and 4. We defined a pathological cut off value of minimum JSW at $\leq$2.0 mm, approximately equivalent to mean minimum JSW ÷ 2 SD in both sexes; and according to the findings of Lanyon *et al.*[7]. We defined a pathological cut off value of maximum subchondral sclerosis, adding 2 SD to the mean values in both sexes. The corresponding pathological values of subchondral sclerosis were calculated to $\geq$5.64 mm in men and $\geq$5.37 mm in women. Frequencies of hips with pathological minimum JSW, pathological subchondral sclerosis, osteophytes and cysts, and sex-related differences in frequencies are summarized in Table I.

AGE AND RADIOLOGIC FEATURES OF HIP OA

Pathologically reduced JSW is significantly correlated to increasing age (*P* range, 0.00–0.005; OR range,

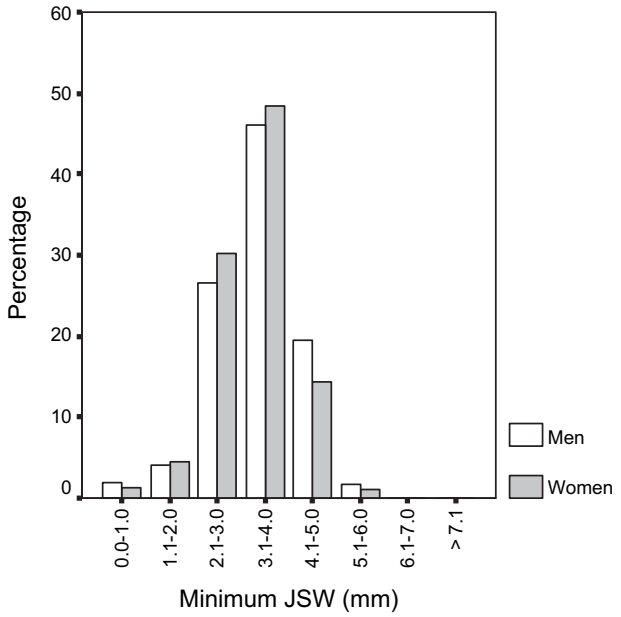

Fig. 3. Minimum hip joint space width distribution.

1.03−1.08). The association between minimum JSW and age is slight in males, and progressively more pronounced in females after the fifth decade [Fig. 5(a, b)]. Formation of osteophytes and subchondral cysts are positively correlated to increasing age in both sexes (*P* range, 0.00−0.019; OR range, 1.0−1.1). We found no significant association between pathologically increased subchondral sclerosis and age in either sex (*P* range, 0.13−0.83; OR range, 0.8−1.0).

BMI AND RADIOLOGIC FEATURES OF HIP OA

We found no significant associations between BMI and recorded radiologic features of hip OA (*P* range, 0.10−0.66; OR range, 0.9−1.0).

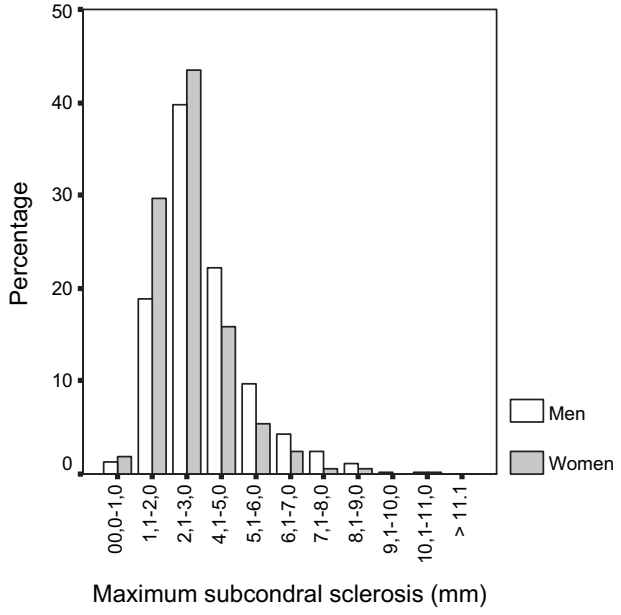

Fig. 4. Maximum subcondral sclerosis distribution.

OCCUPATION AND RADIOLOGIC FEATURES OF HIP OA

We found no significant relationships between radiographic features of hip OA and type and duration of occupations, be they sedentary or involving repeated daily lifting (*P* range, 0.09−0.98; OR range, 0.7−1.0).

INTER-RELATIONSHIPS OF RADIOGRAPHIC FEATURES OF COXARTHROSIS

We found 105 male hip joints and 167 female hip joints with pathologically reduced JSW according to the predefined critical limit of $\leq$2.0 mm. In these hips, the *primary* hip joint OA discriminator of minimum JSW $\leq$2.0 mm was significantly inter-related to the set of *secondary* radiographic features of OA constituted by subchondral cysts, osteophyte formation and pathologically increased subchondral sclerosis ($\geq$mean sclerosis + 2 SD). That was the case in both sexes and on both sides. Subcondral cyst formation had the closest association to pathologically reduced minimum JSW with odds ratios ranging from 9.2 to 38.6 (Table II).

Discussion

We found important sex-related differences in the distribution of radiologic features of hip OA in 3685 pelvic radiographs. We found significant inter-relationships between the recorded radiologic features. Only age of the investigated individual parameters of age, BMI and occupational exposure proved to influence radiologic features of hip OA significantly.

At present pelvic radiographs are the most cost-effective and precise modality for the study of degenerative hip joint disease in larger cohorts. There are, however, some inherent problems in this: (1) a consensus definition of radiographic OA does not exist, and (2) an incomplete knowledge of the natural distribution of the cardinal radiologic features of degeneration in asymptomatic subjects[10].

Both these problems are reflected in the epidemiology of individual risk factors of hip OA. Definition of hip OA varies immensely in the literature, researchers using minimum JSW, the need for hip replacements (THR), or composite radiologic scores as primary inclusion criteria, which means that comparisons between studies are difficult. After all, orthopaedic surgeons have individual criteria for listing patients to THR's.

In this study we found a significant male overrepresentation of pathologically increased subchondral sclerosis, osteophytes and cysts, which means a comparatively higher prevalence of male hip OA, if assessed by global scores emphasizing these features. For instance, the widely used Croft score is based solely on male urograms[1]. However, the study also revealed a significant decrease in minimum JSW by age in both sexes, but progressively more so in women, supporting the findings of Lanyon *et al.*[7]; after the fifth decade the frequency of minimum JSW $\leq$2.0 mm in females superseded male frequency, thereby equalizing prevalences of hip OA, if minimum JSW is used as the primary inclusion criteria.

We found that our primary OA criterion of reduced JSW was significantly inter-related to cysts, pathologically increased subchondral sclerosis and osteophytes. The formation of cysts had the closest association to reduced minimum JSW, while osteophytes was the radiographic OA feature most often encountered in hips with pathologically

Table I
Radiologic features of hip osteoarthritis distributed by sex. Sex-related differences in frequencies of individual features

	Men ($n = 1397$)		Women ($n = 2289$)		Sex-related differences (men/women)					
	Right hip	Left hip	Right hip	Left hip	Right hip			Left hip		
Parameter	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*P*	SED	95% CI	*P*	SED	95% CI
Minimum JSW: $\leq$2 mm	50 (3.5)	55 (3.9)	85 (3.7)	81 (3.5)	0.78	0.006	−0.01–0.01	0.52	0.006	−0.00–0.01
Maximum sclerosis: $\geq$mean + 2 SD	63 (4.5)	86 (6.1)	42 (1.8)	61 (2.6)	0.00	0.040	0.30–0.46	0.00	0.04	0.30–0.46
Osteophytes	102 (7.7)	89 (6.3)	82 (3.5)	76 (3.3)	0.00	0.007	0.02–0.05	0.00	0.007	0.01–0.04
Subcondral cysts	21 (1.4)	32 (2.2)	25 (1.0)	16 (0.6)	0.27	0.003	−0.003–0.01	0.00	0.003	0.007–0.02

Subcondral cysts: number of hip joints with formation of cysts regardless of localization; osteophytes: number of hip joints with formation of osteophytes regardless of localization; SED: standard error of difference; 95% CI: 95% confidence interval.

reduced minimum JSW. It is generally acknowledged that the singular recording of minimum JSW is superior to the readings of other radiographic features of hip OA both in terms of reproducibility and the monitoring of disease progression over time[11]. If estimates of hip OA prevalences are uncritically founded on the recordings of cysts, osteophytes and subchondral sclerosis, one runs the risk of inflating male prevalence of hip OA while underestimating

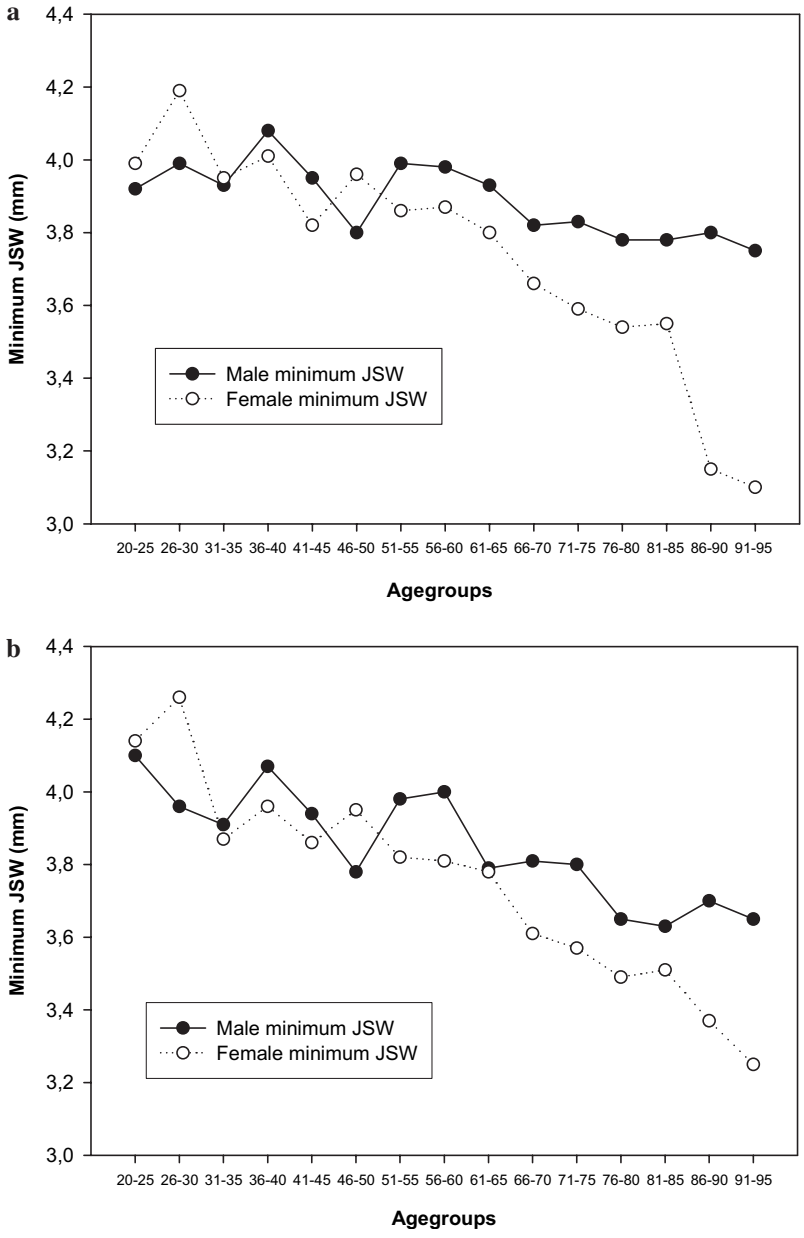

Fig. 5. (a) Right hip minimum joint space width and agegroups. (b) Left hip minimum joint space width and agegroups.

Table II

Distribution of subcondral cysts, osteophytes, and pathologically increased subcondral sclerosis in subjects with pathologically reduced JSW (≤2.0 mm). The inter-relationships of the primary radiographic OA discriminator (in hip joints with minimum JSW ≤2.0 mm), and the secondary radiographic OA discriminators (cysts, osteophytes, and pathologically increased subcondral sclerosis in these hip joints) are presented with significance value and odds ratios

	JSW ≤2.0 mm *n* (%)	Cysts			Osteophytes			Sclerosis ≥2 SD		
		n (%)	*P*	OR (95% CI)	*n* (%)	*P*	OR (95% CI)	*n* (%)	*P*	OR (95% CI)
Male right hip	50 (3.5)	12 (24.0)	0.00	21.5 (7.4–62.4)	22 (44.0)	0.00	9.5 (4.8–18.5)	15 (30.0)	0.00	6.3 (2.9–13.9)
Male left hip	55 (3.9)	17 (30.9)	0.00	12.1 (4.6–31.6)	24 (43.6)	0.00	9.3 (4.7–18.5)	16 (29.1)	0.01	2.6 (1.1–6.0)
Female right hip	86 (3.7)	16 (18.6)	0.00	9.2 (3.1–27.4)	17 (19.8)	0.00	7.0 (3.7–13.2)	17 (19.8)	0.00	10.4 (4.7–23.1)
Female left hip	81 (3.5)	12 (14.8)	0.00	38.6 (9.7–153.7)	20 (24.7)	0.00	13.6 (7.5–23.7)	14 (17.3)	0.00	4.4 (1.9–10.4)

OR: odds ratio; CI: confidence interval; JSW: joint space width.

the prevalence of female hip OA. In the still widely used OA classification of Kellgren and Lawrence an inherent chronological sequence of radiological features of OA is implicit: reduced JSW leads to subchondral sclerosis and osteophyte formation, which in turn leads to the formation of cysts, and finally to joint deformity. To our knowledge, this chain of causality has not been tested or evidenced in the literature. One may very well argue that deformity of the joint leads to secondary arthrosis, and not the other way around, as is the case with residual hip dysplasia. Only studies of the distribution of features, singularly and in combination, applied to clinically evaluated large cohorts may provide the optimum answer to the best possible clinical case definition of hip OA.

Recent studies suggest a significant relationship between overweight and hip OA. Two general mechanisms have been suggested. Firstly, gaining weight increases the load forces across the articular cartilage and may lead to cartilage breakdown beyond a certain critical limit. Secondly, obesity has been associated to general OA in women, not just of the weight-bearing joints, suggesting an intermediary metabolic mechanism, for instance an increased production of oestrogen[12]. An inverse correlation between osteoporosis and OA has long since been established, further supporting the hypothesis of higher levels of oestrogen in overweight osteoarthritic women.

Vingård[13] found significantly increased odds ratios for the development of hip OA in 239 males between 20 and 50 years, if BMI > mean BMI + 1 SD. Adjusted odds ratios varied between 1.67 and 2.49. The definition of hip OA was the need for THR.

Oliveira *et al.*[14] found significant correlations between hip OA and overweight in 134 matched case–control pairs of women aged 20–79 years. The authors calculated an odds ratio of 3.4 for women with a BMI between 23.91 kg/m^2 and 27.8 kg/m^2. Odds ratios were adjusted for smoking and oestrogen therapy. Definition of hip OA was a composite radiologic score according to guidelines of the American College of Rheumatology.

Marks and Allegrante[15] found BMIs in the overweight and obese range in almost 70% of 586 females and 435 males requiring THR. The authors found that the percentage of overweight or obese subjects with end stage hip OA was higher than the values reported in the adult population generally, but does not state whether this difference was statistically significant.

Cooper *et al.*[16] found a positive relationship of increasing BMI to hip OA in a case–control study of 611 patients listed for THR compared to age and sex matched controls. Ninety-seven percent of patients listed for THR, had radiographic evidence of OA > Lawrence–Kellgren grade 3°, and 83% had minimum JSW ≤1 mm. Odds ratios were adjusted for individual risk co-variates and were 1.9 for men with BMI ≥28 kg/m^2, and 1.7 for women with BMI ≥28 kg/m^2.

In contrast to these studies, Stürmer *et al.*[17], found no correlation of BMI >25 kg/m^2 to hip OA in 420 patients listed for THR.

In the current study adjusted odds ratios for BMI vs minimum JSW ≤2.0 mm, subchondral sclerosis ≥mean + 2 SD, osteophytes and cysts, varied from 0.9 to 1.06, and no significant relationships were found in multiple logistic regression analyses. We did not, in this study, include co-variates such as smoking, oestrogen replacement therapy, or vitamin D intake. Comparison between own findings and other epidemiologic studies in the field of BMI and hip OA are virtually impossible because definitions of hip OA varies so much. However, the well executed case–control study of Cooper *et al.*[16] does not report odds ratios very different from our own.

The relationship between prolonged exposure to occupational lifting and development of hip OA has been investigated by many studies. The nature of occupational exposure most predisposing to hip OA seems to be mixed farming for several decades and daily repeated lifting of heavy loads. Lievense *et al.*[18] found two retrospective cohort studies and 14 case–control studies of sufficient methodological quality in reviewing the literature. Moderate evidence for a positive association between occupational exposure to heavy work loads and hip OA was consistently found, with odds ratios of approximately 3.0. Maetzel *et al.* found 17 studies meeting selection criteria and concluded a weak, but consistently positive relationship between heavy physical labour and hip OA, with odds ratios ranging from 1.4 to 6.0[19]. Usually odds ratios are adjusted for confounders such as participation in sports, smoking, hip injury, and unrelated hip disorders. The authors point out that recall bias: the ability of subjects to accurately recall the magnitude of physical workloads during a lifetime generally constitutes a major limitation of the studies. Definitions of hip OA again varies from minimum JSW ≤4.0 mm in some studies to minimum JSW ≤1.5 mm in others. A well-known bias regarding the relationship between occupation and OA is the possibility that subjects with demanding occupations are referred earlier for THR than subjects with more sedate occupations—because they experience OA as a threat to their livelihood. However, most subjects in the studies are well beyond retirement. There is an almost uniform absence of females in the studies.

Croft *et al.* investigated 179 male farmers and 71 office workers in a case–control study. Hip OA was defined as minimum JSW ≤1.5 mm. If subjects were exposed to heavy farming labour for over 10 years, the authors found an adjusted odds ratio of 9.3 for the development of hip OA, compared to controls[20]. Another well executed study of

Coggon *et al.* of 611 subjects and matched controls concluded that daily lifting of burdens >50 kg for 10 years or longer was associated to an increased odds ratio of 3.2 of developing hip OA. OA was defined as the need for THR. It is noteworthy, however, that no significant association between heavy work and hip OA was found in 401 women of the study[21]. Axmacher and Lindberg found an odds ratio of 12 in male farmers compared to male urban controls for developing hip OA. However, the radiologic diagnosis of hip OA was estimated solely in urograms and colon radiographs without any information on magnification, centering of the X-ray beam or pelvic orientation during recording. Radiologic hip OA was defined as minimum JSW <4.0 mm, which in fact is quite normal[22]. Thelin *et al.* found an odds ratio of 2.6 of developing hip OA in male farmers, forestry workers and fishermen compared to white collar controls. Again, the radiologic diagnosis of hip OA was obtained from mixed pelvic radiographs recorded for other purposes without any information of recording technique. Cut off value of minimum JSW was <3.0 mm, which is well inside 1 SD of the mean values of minimum JSW found in our study and in Lanyon *et al.*'s study of JSW in asymptomatic men[7,23].

In our study of an entirely urban population we found no statistical significant relationship between exposure to repeated daily lifting and development of hip OA in neither men nor women, odds ratios adjusted for age and BMI ranging from 0.7 to 1.0, when applying binary logistic regression analyses.

We find that the best possible definition of radiologic OA rests on standardized radiographs, which are reported with sufficient detail on radiographic technique, and on a thorough knowledge of the distribution of cardinal radiologic features of OA in both symptomatic and asymptomatic subjects, thereby improving comparability of epidemiological research.

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